*Near-Field Cosmology with Dwarf Elliptical Galaxies*
*Proceedings IAU Colloquium No. 198, 2005*
*H. Jerjen and B. Binggeli, eds.*

doi:10.1017/S174392130500390X

# The Tully-Fisher relation of spiral galaxies

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**Abstract.** The Tully-Fisher (TF) relation is an empirically establish correlation between the luminosity of a spiral galaxy and its rotational velocity (Tully-Fisher, 1977). We used the Tully-Fisher relation to probe the dark matter (DM) distribution in the optical regions of spiral galaxies. We investigated a sample of rotation curves that includes 957 galaxies. We applied a new technique that takes advantage of the full knowledge of the galaxy rotation curves.

**Keywords.** galaxies: kinematics and dynamics, dark matter

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The Tully-Fisher (TF) relation is an empirically established correlation between the luminosity of a spiral galaxy and its rotational velocity (Tully & Fisher 1977). It has two important properties. First, it is used to obtain cosmological distances. Second, it can be used to study the dynamical properties and evolution of galaxies. We used the TF-relation to probe the dark matter (DM) distribution in the optical regions of spiral galaxies. We investigated a sample of rotation curves (Persic & Salucci 1995) that includes 957 galaxies (see also Mathewson, Ford & Buchhorn 1996). We applied a new technique that takes advantage of the full knowledge of the rotation curves of galaxies. More specifically we have established several new Tully-Fisher like relations, each one related to a different radius, namely at the following fixed fractions of the optical radius $R_{opt}$ (corresponding to about three length scales), i.e. at: 0.2, 0.4, 0.6, 0.8, 1.0, 1.2. The standard TF-relation is evaluated only at just one radius, usually about $R_{opt}$.

The thorough analysis of our data, which includes 15 000 independent measurements, is done by means of the linear regression models $M_{Bi} = a_i + b_i \log V(R_i)$, where the parameters $a_i$ and $b_i$ are found by least squares. We plot the six TF relations at the above specified radii and in Table 1 we present their main characteristics.

Col(1) – Isophotal radius, Col(2) – Intercept value (a), Col(3) – Standard error of a, Col(4) – Slope value (b), Col(5) – Standard error of b, Col(6) – Scatter, Col(7) – Number of points

In Fig. 1 we show the scatter of these TF-like relations as a function of their reference radius $R_i$. Notice that at 0.2 $R/R_{opt}$ the scatter is very large because of the influence of the bulge, but, otherwise, it is always very small.

In Fig. 2 we show the slope of the TF-relations. As is apparent the slope steadily increases with increasing distance from the center.

**Table 1.** The TF-relations at different radii

| $R/R_opt$ | *zero point* | *error* | *slope* | *error* | *SD* | *N* |
|---|---|---|---|---|---|---|
| 0.2 | −11.78 | 0.103 | −4.77 | 0.054 | 0.366 | 739 |
| 0.4 | −8.207 | 0.068 | −6.141 | 0.033 | 0.185 | 786 |
| 0.6 | −5.769 | 0.063 | −7.102 | 0.029 | 0.146 | 794 |
| 0.8 | −4.22 | 0.09 | −7.718 | 0.042 | 0.17 | 657 |
| 1.0 | −8.2 | 0.146 | −8.197 | 0.067 | 0.208 | 447 |
| 1.2 | −1.98 | 0.261 | −8.639 | 0.118 | 0.253 | 226 |

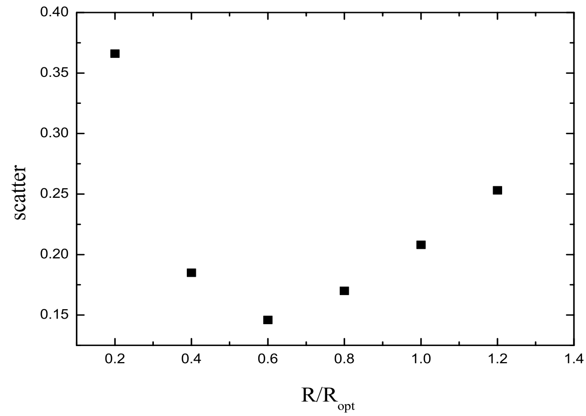


**Figure 1.** The scatter of the TF-relations as a function of radius

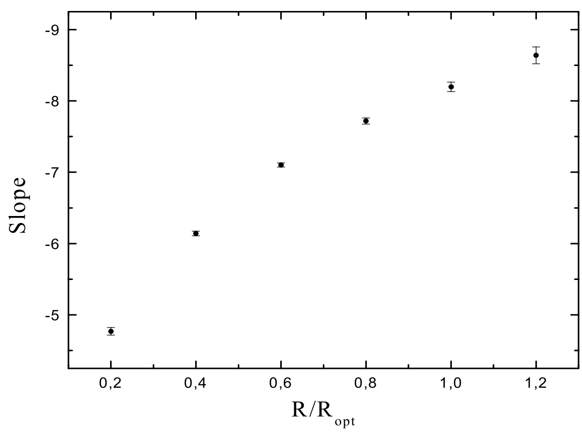


**Figure 2.** The slope of the TF-relations as a function of radius

The first analysis of this data shows that the dark matter fraction depends on the radius and on the galaxy luminosity. We plan to study quantitatively the behavior of scatter and slope in different models of mass distribution.

## References

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